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GEOLOGY AND PUBLIC SERVICE¹

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THE subject on which I have been asked to speak presupposes a science that is practical—one that serves others than its devotees. It is only utilitarian geology that I shall discuss—that side of the science by some termed economic geology, by others applied geology; but for utilitarian I shall take the definition credited to Tolstoi—solely what can make man better. This human side of scientific work is simply part and parcel of its wider purposes, and to recognize its utility is to ennoble science rather than to degrade it.

Five years ago, in the presidential address of the Geological Society of Washington, Mr. Brooks gave some quantitative expressions of the marked tendency in geology toward practical problems. This growth in the utility of our science during the last quarter of a century was measured by the activities of state geological surveys and of universities, as well as of the Federal Survey. Further, as Mr. Brooks pointed out, the trend that has made applied geology the dominating element in our science has not been limited to the North American continent; it has been world-wide.

The United States Geological Survey was created for public service in the widest sense. Congress intended it to be a large factor in placing “the work of national development and the elements of future prosperity upon the firm and enduring basis of truth and knowledge.” To quote further the language used in the debate of thirty-eight years ago, “the institution and continuance of an effective geological survey” was then regarded as a measure such “as will prevent the waste of natural resources, clear the way of progress, and promote the triumphs of civilization.” Such a declaration of purpose, though more eloquent, was in full accord with the report of the National Academy of Sciences and surely leaves the federal geologist free to devote his science to public service, without fear of just criticism.

The present status of our science forecasts an even larger usefulness in the future. In oil geology alone the profession has won a place in the business world undreamed of 10 or even 5 years ago. When we see single corporations having in the field more oil geologists than the United States Geological Survey, we realize that our federal service must rest its claim to consideration on something other than size.

¹ Address given before the Geological Society of America, Albany, N. Y., December 27, 1916.

In other lines, too, the science of geology is gaining the recognition that we perhaps feel has too long been withheld. Especially gratifying is the tendency of constructing engineers to consult geologists in matters related to large engineering projects. To the trained geologist, familiar with the many kinds of rocks and their varied habits of assembling together, it has seemed strange indeed that so many engineers have gone ahead on the theory that rock is rock and that nothing can be learned of the third dimension of the earth's crust in advance of actual excavation. Possibly, however, some of this blame may be laid at our own door, for geologists do not always seem firm believers in the practical side of their own science, and only in these later years have we learned to talk of the facts of geology with any approach to the quantitative exactness that engineers expect. Even now a wide difference in degree of scientific accuracy and refinement may be noticed in the manner in which we handle data in our own particular specialty and data relating to some other phase of geology or to another branch of science. This lack of respect for specialized science may sometimes be found in our own midst, even though we call ourselves specialists.

The opportunities for expansion are plainly before us, for the practical worth of geology is now widely acknowledged. How can we best increase the contributions of geology to mankind? Has the science other possibilities? What is its relation to public service?

In the last three years it has been gratifying to see the preparedness issue broaden so as to include the contingencies of peace as well as of war, to hear of industrial as well as of military preparedness. But back of both, and indeed including both, there needs to be a more vital preparedness—the preparation for citizenship. In any day and generation this test can and should be applied to any religion, philosophy, or science: Does it make good citizens? It is therefore with real concern that we ask ourselves this question: Does geology contribute to citizenship?

The president of this society in a thought-inspiring address at the University of Chicago convocation this year, made reference to a little red-brick building here in Albany, which this city does well to preserve—the laboratory of James Hall. And I believe Doctor Clarke is right in regarding that small and plain structure as the source of broad conceptions of the philosophy of evolution, which, radiating outward, have influenced not only our science, but also your state and our country.

The sciences of geology and astronomy are founded upon postulates which they in turn have done much to make real—the permanence and universality of natural laws as we of to-day know them. By training and almost by second nature the geologist may be a conservative in politics; at least, the believer in natural law should possess the patience to wait for results in this particular epoch of this geologic era. By

training the eye to see far back into the earth's remote past, geology can add to our power to put correct values on the events and changes in the brief present in which we happen to live.

There is another way in which geology especially contributes to the training of an enlightened citizen. Some one has said that a man's breadth of mind is measured by the diameter of his horizon. Geology as a study and especially as a profession leads to wide travel, and travel surely maketh the broad man. This advantage may seem to us so much a matter of course that we underestimate its silent influence in fitting us for citizenship. The geologist has the opportunity to think in terms of country rather than of community, of continents rather than of country; and his broader outlook over the world surely gives perspective, just as his longer view back into the past gives poise.

In an address at the University of Illinois I referred to the inspiration and incentive which come from Professor Chamberlin's conclusion that there is good reason for measuring the future habitability of the earth in millions or tens of millions if not hundreds of millions of years. This belief in the high probability of racial longevity is, as you know, the result of an exhaustive analysis of the past as revealed by geology and of the future as forecast by astronomy. But now I wish to add my personal acknowledgment to our greatest American geologist for the inspiration gained from a talk with him several years ago, when I realized that it was this scientific expectation of the evolution of humanity continuing through these millions of years that was prompting him to public service not limited to his own city or country.

The geologist's appreciation of that delicate adjustment of earth to life by means of which "life has been furnished a suitable environment for the uninterrupted pursuit of its ascensive career" and the geologist's vision of the continued adaptation of the earth to the uses of man together constitute a real call to larger service. No one has more reason than the geologist to believe that wise utilization of nature is essential, now that man the engineer has become so effective a geologic agent; nor can the geologist overlook the need of a social organization that will adequately serve the larger and higher demands of humanity, now that man himself controls in large part the adaptation of this earth to man in his further evolution. We believe that the Golden Age is in the future, but it will be of man's own making.

This tribute was paid a year ago to the work of the geologist and engineer by one in high official position who has a vision of things as they are and are to be—Secretary Lane:

This is a glorious battle in which you are fighting—the geologist who reads the hieroglyphs that nature has written, the miner who is the Columbus of the world underground, the engineer, the chemist, and the inventor who out of curiosity plus courage plus imagination fashion the swords of a triumphing

civilization. Indeed, it is hardly too much to say that the extent of man's domain and his tenure of the earth rest with you.

Keeping in mind these thoughts of the larger things of time and space, I desire to mention what may be termed the professional obligations of geologists. As scientists, working in a practical world on problems that have come to have very practical bearings, we may need to take special care that our scientific ideals be not lowered. As an associate in a large group of geologists I have been proud to see the science of geology win this larger recognition in the market-place, for I hope to see our science cooperate in the further raising of business ideals. There can, however, be no double standard for geologists—one for guidance in research work in pure science, the other for purposes of professional exigency. As geology enters into the larger sphere of usefulness, there naturally come to the geologist opportunities somewhat different from those of the laboratory or lecture room. The profession in its newer activities encounters stresses for which new factors of safety must be figured. As I look at the demands now made upon geologists, the temptation to lower our ideals comes not so much when our task is to find something as when we may be called upon to prove something.

The geologist sent to South America to determine the extent of an ore body or to Oklahoma to discover an oil pool must needs bring into play every resource of a trained mind in order to wrest the truth from secretive nature. This is a contest which calls for geologic science at its best, and in which scientific ideals are in no danger. A demand of another kind, however, is made upon the geologist who is asked to certify to some doctrine in the conservation creed, it may be, or to testify in support of some contestant in a court of law. Professional demands of this type may cause our scientific ideals to tremble, if indeed they do not suffer a tumble. It is for this reason that a geologist's ideals are safer in the field than in the court-room; Mother Nature is a better associate than the goddess who goes blindfold.

Yet the problem faces us and we must answer our own question: What are the professional obligations of the geologist? Possibly the official geologist is less exposed to temptations of this type; he is allowed to make his testimony follow the evidence. At least I remember that the Survey geologist published, uncensored, his estimates of coal reserves, even though his statement did not fit in with the popular argument for conservation; nor was the official opinion required by the statute as to the influence of forests on stream flow given until field examinations by geologists and engineers furnished a basis of fact; nor again do I believe that the federal geologists who testified as to the mineral character of petroleum were in any degree influenced in their opinion by the chance circumstance that this was the government's con-

tention. On another occasion the federal geologist whose duty it was to defend the official classification of land in a western state had definite instructions to reverse the Geological Survey's position in the matter if new evidence should indicate an error of judgment, even though such action would have enabled the railroad claimant to win the land. Nor should a government geologist hesitate to file notice of a correction in some assays earlier introduced as evidence, even though he thereby strengthened the land claimant's contention. Here, of course, the issue was plain; the duty of the public servant was to see that truth prevailed, even though the government might seem to lose its case. In two other of the instances I have mentioned some degree of temporary popular favor and freedom from current newspaper criticism could have been gained by a different course, but I believe that in the end the good name of science would have been besmirched.

Yet in courts of law we now see geologists testifying as experts on both sides of the case, and too often as experts on subjects on which they would not be regarded as specialists by their fellow geologists, or at least on specialized phases of geology which they themselves might hesitate to discuss before this society. But even when such opposing witnesses are both eminently well qualified, what is the spectacle presented to the public? One expert testifies that the thing under discussion is absolutely jet-black; the other that, as he sees it, it is purest white; whereas it may be that without the legal setting the same thing would present to most of us varying shades of gray, or perhaps some one using a higher power of lens might call its general color effect rather spotted. I regret to add that this suppositional illustration is almost paralleled by an important case in which two of my own friends, both honored fellows of this society, were the opposing expert witnesses; and afterward the judge told me that he could believe neither, although he would have taken the unsupported opinion of either one had this geologist been in the pay of the Court! Does not such a statement by an eminent jurist put geologic experts on a par with other expert witnesses, and would it not be a "safety first" measure for geologists to decline professional work of this type until the day comes—and I think it is not far off—when the court will summon the expert witness and compensate him for his services to the state in telling the whole truth and not that special part of the truth which favors one litigant? This society wisely put itself on record last year as recognizing the urgent need of this reform in legal procedure, but to be effective resolutions need to be adopted by each individual geologist.

As first suggested to me, the subject on which I was invited to speak to-day was geology in the national service, but I feared if thus expressed my topic might seem to limit opportunities for service to the nation to those of us who are on the Federal Geological Survey. The president

and more than a score of other fellows of this society are in the public service as officials of the several states; and too much credit can not be given to the long succession of state geologists who for nearly a century have both contributed to the science of geology and guided the development of their states. A few years ago Doctor White, in addressing the West Virginia board of trade as its president, referred to the function of the state geologist as that of "a kind of mentor or guardian of the state's natural economic resources."

Yet I would not limit the obligation for public service to those of us who happen to be public servants. The use of the United States Geological Survey as a training school for professional geologists in private practice can not be regarded as wholly a hindrance to the nation's business when viewed in a large way. The spirit of public service can be carried over into the work outside the official organization, and I like to believe that there is a persistence of this same purpose on the part of our Survey graduates that will lead them to do their share in planning for the utilization of the nation's mineral wealth, not merely so as to increase dividends for the corporations that employ them or to assist a few capitalists in speculative endeavors to corner some limited resource, but also so as to benefit society in a large way through future decades. Why can we not be trained scientists and professional geologists and loyal citizens at one and the same time?

President Vincent has referred to the sweeping indictment of professional schools, with all their modern efficiency, as turning out graduates "bent upon personal success and regarding the public as a mine to be worked rather than a community to be served." In whatever degree unwarranted, this criticism, as President Vincent points out, is in itself encouraging as a sign of general discontent with self-centered careers. And there is another approach to this subject of the civic obligations resting upon us as geologists. Those of us who have shared in the benefits of the American educational system, up to and including the university, must realize to what a large extent our education has been gratuitous. As Doctor Becker once expressed it to me: "Men who seek or use their university training solely for their personal advantage are almstakers. Only by public service can educated men repay the debt they incur and thus fulfil the designs of the founders."

It is a fortunate sign of the times that applied science is touching more and more upon the human and social side of its work. Measure of the breadth of view already attained in this public service idea is found in this month's issue of a leading technical journal, *Metallurgical and Chemical Engineering*, wherein the longest editorial bears the title "Expensive Slums." Social responsibility is acknowledged and civic duty set forth in the closing sentence of this editorial:

It is needful for industries that they be in good standing, and they can not maintain good standing so long as they have slum attachments.

So too it is eminently fitting that in a technical volume bearing the title "Iron Ores" the closing chapters should discuss the large social questions of public and private policy. The author, a geologist and fellow of this society, properly regards the social value of iron just as worthy of his thought as the purity of its ores. Indeed, it is simply the need of society that makes the mineral hematite an ore and thus the object of the geologist's special study.

In my administrative report for the past year I had occasion to refer to a professional paper by Doctor Gilbert now in press. In his wonderfully broad and complete investigation of the mining-débris problem in the Sierra Nevada the geologist began with the antagonism of mining and agriculture, but he soon found that his research also involved questions of relative values between commerce and irrigation and power development. So this report, thoroughly scientific in data and method, will illustrate how high a public service can be directly rendered by the geologist. Nor is this a new departure: some of us belong to the generation to whom Monograph 1 of the United States Geological Survey was a source of inspiration in our student days. That monumental work by the same author, a classic in its exposition of geologic processes, was the result of an investigation also planned as the answer to an economic question of large civic importance. Director King thus stated in 1880 the purpose of the Lake Bonneville monograph:

Is the desert growing still drier or is it gaining in moisture are questions upon the lips of every intelligent settler in that region.

Moreover, aside from making our science more human, there is the larger need of humanizing ourselves. Doctor Favill, of Chicago, in addressing a group of business men last winter, gave them this professional advice: "Have an outside interest;" and the outside interest he prescribed was political or social activity. This physician regarded it as conducive to individual happiness as well as helpful to society that "every honest, able-bodied, red-blooded, clear-thinking man should have his mind set on what is the right thing for him, for his community and his country to do."

The Austrian geologist Suess may furnish the best illustration of the happy combination of scientist and citizen. He was a leader not only in the science of the world but in the parliament of his country. A close student of geologic discovery even after reaching fourscore years, Professor Suess was equally keen to learn of political progress the world over, and in a letter to me within a year of his death he inquired particularly about the reforms in public-land administration in the United States.

Appreciation of civic duties has fortunately not been lacking in

American geologists: one of the best volumes on citizenship was written years ago by Professor Shaler, and it is worthy of mention that in that book he emphasized not so much the opportunities for service in high station, for he states that the best work in the practise of citizenship is done in the town or precinct.

In these fields of activity the spirit of the freeman is made; if the local life be not of a high citizenly character, all the constitutions in the world will not give the people true freedom.

And it has been said of Professor Shaler that he not only preached good citizenship, but, what was better, he never neglected his own political duty. While we must properly look upon enlightened citizenship as a 365-day-a-year undertaking, there is one day in each year, or two years, or four years when a special duty is laid upon each citizen of the state and nation, and in these times no one is better qualified to exercise the right of suffrage than the geologist. A few weeks ago, too, we learned that even in this great country of ours, where eighteen million ballots were cast at a single election, individual votes have not lost their power to influence the result. And how true it is that education of the scientific type is essential to a correct understanding of many of the issues of the day.

In a leading editorial, the day before election, a nonpartisan writer mentioned the discussion of prosperity as a campaign issue and remarked that

Analysis of the interminable political arguments about it would probably disclose that in the main they consist of about 95 per cent. imagination and exaggeration, in equal proportions, 5 per cent. of fact, and of unbiased opinion not a trace.

A low-grade ore of that composition surely needs a citizen who is a scientist or engineer to make the necessary separation and concentration.

Take another political and economic issue that must be faced—the length of the working day. Professor Lee, of Columbia, recently emphasized the fact that the determination of the proper number of hours of work is primarily a problem of physiology, although too often economic and social considerations have been made paramount. Must we not agree with the physiologist, at least to the extent of admitting that it is all too evident that here is a present-day issue of large importance which deserves scientific rather than political treatment? Or we may say, here is a civic question that demands the attention of citizens who have had scientific training. Who can better weigh the opposing elements of this question—on the one side the cumulative fatigue of the individual producer and on the other the economic requirements of society as the consumer?

To mention just one other of the larger issues of the moment, the

railroad question is one so intimately tied up with the geographic relations of mineral resources that the geologist citizen is eminently well qualified to consider how dependent is industrial opportunity upon fair freight rates. When we realize that the railroad earnings from the transportation of the raw products of the mine alone exceed the earnings from passengers and also exceed the freight receipts on all products of both farm and forest, we have a measure of the interdependence of the mineral industry and the railroads. The proper regulation of common carriers thus becomes a prerequisite of the full utilization of our mineral resources, and on such a political issue no citizen should have a larger interest or a more intelligent opinion than the geologist. It is therefore more than a happy coincidence that President Van Hise has rendered large service to society in his contributions to the railroad and labor problems; the broad training of the geologist is being utilized in the work of the publicist.

Have I not already shown that the geologist is well qualified by his special training to serve his day and generation, not only in the capacity of professional adviser but, better than that, in the rôle of fellow-citizen? It may be rather late in this discourse for me to select a text, but there is an old saying in the book of Proverbs that has been much in my mind for several months—"Where there is no vision the people perish." Imagination is necessary in our science, and it is equally essential to the larger citizenship. I believe the geologist possesses the vision; his duty and privilege is to let that vision guide him to a larger public service.